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MICROBES: WHAT THEY ARE, AND THE PARTS THEY PLAY.

On 23rd January, 1896, a public lecture on the above subject was delivered in the Waterloo Rooms, Glasgow, under the auspices of the Glasgow and West of Scotland District Council of the National Registration of Plumbers, by Dr. John Glaister, D.P.H., F.F.P.S.G., etc., Professor of Forensic Medicine and Lecturer on Public Health, Saint Mungo's College, Glasgow. There was a large audience of members of the public interested in sanitary advancement as well as of master and operative plumbers. Ex-Bailie Crawford, Convener of the Health Committee of the Corporation of the City of Glasgow, presided. The chairman, in introducing Professor Glaister, remarked that from the point of view of the public authorities bacteriology was daily becoming more and more the guiding light to their operations—so much so that the Corporation of Glasgow had determined in their new Sanitary Chambers to institute a bacteriological laboratory. It would be impossible for them to combat in the best manner the infectious diseases of the day, which had their origin in the various micro-organisms, without the intelligent and conscientious co-operation of the plumbers throughout the country. (Hear, hear.) They now felt that with the education of apprentices, and with the registration of qualified journeymen, inaugurated by the Worshipful Company of Plumbers of London, and carried out by means of district councils all over the country, they might look forward to the future in this connection with great confidence. (Applause.)

The following is the substance of the lecture:—

The world in which we live may, for the purposes of this lecture, be divided into two great sections, one of which is comprehensible by us through the ordinary channels of the senses, viz., by sight, by hearing, by touch, by taste, and by smelling, the other being beyond the range of one of these senses at least, viz., that of sight. Consequently the universe is divisible into that which is knowable by our present

range of vision, and that which is beyond the visual ken, and therefore unknown. It is into this comparatively unknown land that we must make excursions to-night to make the acquaintance of microscopic beings which, though infinitesimally small, are wonderfully potent. Had we been provided by our Maker with organs of vision about one thousand times stronger in visual power than those we presently possess, it would have been easy for us to perceive the innumerable organisms of which mention has been made, but which, with our unaided eyes, we cannot perceive, and in comparison with which the visible animated creation would sink into utter insignificance. Science, however, has come to our assistance, and has provided us with optical instruments of such precision that we are able to view objects magnified up to fifteen hundred times, and which, as it were, form our new eyes.

What is a *microbe?* It is literally a small living thing, so small as to require microscopic aid to see it, and so much alive that it may be the cause of great mischief. The name given has this advantage over many of the others which have been used to designate it that it exactly expresses what the thing is without committing the user to any theory regarding its genesis, or in respect to whether it belongs to the vegetable or animal kingdom; whether, in short, it is a small animal, as is believed by some, or a small plant, as is believed by others. The other name which is given it, and which practically has the same significance, is *micro-organism.* Microbes exist everywhere—in the air we breathe, in and on the earth upon which we walk, in the water we drink, within and without our bodies, inside and outside our homes, and they are present in myriads in the place in which we are now assembled. As I have said elsewhere, "they operate in curious ways and in diverse places, conservatively and destructively, and they are both the friend and the foe of man." They rid the earth of dead and decaying matter; they form innocuous chemical compounds out of this offensive material; and we are, in our everyday existence, brought into contact with the results of their operations. For example, they make our milk turn sour, our

butter to become rancid, our bread and jams to become mouldy, and they are the prime factors in the production of all the infectious diseases. They produce food for the growth and sustenance of plants, and they bring about diseases of plants themselves. Their action, therefore, is far-reaching, and they are ubiquitous. To know them and their habits and to watch the nature of their operations is to enable us to overcome, in a certain degree, and with increase of this knowledge, to a greater degree, the evil action of those of them which are potent for harm. My object in this address is not only to draw your attention to microbes as understood in the scientific sense, but also to some microscopic forms of life which are prejudicial to the health of men and animals.

Hygiene is that branch of medicine which, by removing the possible causes of disease, either prevents their operation or modifies their action. Hence it has been called preventive medicine, in contradistinction to curative medicine, or that department of medicine which has to do with the healing of the person after he is sick. Hygiene, therefore, takes to do with everything which tends to the causation of disease; and as the causes of disease are so many and the channels into the body by which such causes may operate so various, the science embraces very many subjects. It has to do with the air we breathe, to see that it is pure; with the food we eat, that it is not diseased; and with the water we drink, that it is not contaminated by foul matters; with the raiment with which we are clothed, the houses we inhabit, and a great many other like subjects. One of the principal of these is the microscopic forms of life which harass our lives, cause much pain and discomfort, and are productive of so many deaths. All of these microscopic beings are parasites; that is, they live and thrive at the expense of their hosts, and by reason of this action they cause prejudice and loss of health to their hosts.

Hygiene or sanitary science is very old. The oldest sanitary code in the world is that which was laid down by Moses in the oldest book in the world, viz., the Bible, and which is chiefly found in the book of Leviticus. It is well

worth careful study. In this code are to be found the fundamental principles of infectivity, of isolation of the infectious sick, of quarantine, and of disinfection. The priest of that time was not only charged with the cure of souls, but also with the cure of bodies. Moses laid down in the law certain instructions for the guidance of the children of Israel, not only in respect of the points already indicated, but also in respect of the cleanliness of the body, and of the healthy character of the flesh meat of which the Jews were to eat. Not only so, but certain definite instructions were given in respect of certain animals the flesh of which was not to be eaten, and of certain parts of every animal which it was unlawful to use. This may be taken as a text by which may be illustrated the possible dangers to man by partaking of the flesh of diseased animals.

The Israelites were forbidden to eat the flesh of, among other animals named, the pig and the hare. It would appear from the record in the Old Testament that the division which separated these animals from the others was at once a superficial and an arbitrary one, and we cannot see, in the division made, any physiological reason why it was so made. It is quite likely, however, that Moses must have observed in his experience harmful effects to arise from the partaking of the flesh of these forbidden animals, or, at all events, must have attributed to the flesh of these animals certain results which stood in the relation of cause and effect. However that may be, modern research has abundantly illustrated the prudent foresight of the law-giver, inasmuch as by the eating of the flesh of the pig certain very disagreeable and dangerous diseases may be conveyed to man. I will only mention two of these, viz., tapeworm and trichinosis. The tapeworm from the pig which grows in the intestinal canal of man is one of the most difficult to dislodge, and therefore is more persistent in its harmful effects than any of the other forms. A tapeworm is a very interesting animal. It requires to pass through the bodies of two hosts before it attains its mature condition, one of the hosts being one of the lower animals,

the other being man. The worm which passes from the body of the pig to that of man has, even in its immature form, round what is popularly called its "head," a series of sharp hooklets and a series of "suckers," by which double mode of adherence it fixes itself upon the inner lining of the intestine, and hence the difficulty of dislodging it. This is the cycle of its development. The pig is a very foul feeder, and it, perhaps, chances across fragments of a tapeworm which has been thrown out of the body of a sufferer. The eggs or seeds develop in its body, and the immature worms bore their way into the flesh of the animal. The animal is killed for food. If attention be paid to the flesh, it will be found dotted over with small yellowish specks. Such flesh is called "measly pork." A person eats by choice, or chance, a rasher of this raw bacon, or the ham undercooked. The juices of the stomach dissolve the little bags in which these immature worms are lodged, and by the aid of the warmth of the body and the plentiful nourishment they receive, they at once develop into the mature worm, called tapeworm, because the worm is flat, ribbon-like, or *tape-like* in shape, and consists of a series of these tape-like segments united together.

Strangely enough, the same kind of tapeworm is found in the hare. This fact is not so well known by the public; and since a hare is considered a dainty dish, the importance of this knowledge is obvious. The picture, which is shown on the screen conforming to the description before given, is a micro-photograph of a specimen taken from a hare which is in my possession.

The other disease transmissible to man by the flesh of a diseased pig is called *trichiniasis* or *trichinosis*. If a minute piece of such flesh be examined under the microscope, it will be found to be infested by a large number of minute worms called *trichinæ spiralis* (from the Greek *trichos*, a hair, and the Latin *spiralis*, spiral or corkscrew-like), or spiral, hair-like worms, which lie coiled up in little bags or cysts. When such flesh is eaten raw or underdone, these little bags are dissolved, the worms are liberated, and they immediately begin to bore into the

flesh of the person, producing very painful, dangerous, and oftentimes fatal results. The micro-photograph demonstrates the worms as described.

Having pointed out the evils, it is necessary to say how they may be avoided. This may be effected in two ways, one of which ought to be the duty of the municipality, the other of the private individual, viz., (1) *the efficient inspection of the carcases of all animals killed for human food;* and (2) *thorough cooking of the meat.* On the Continent, especially in France and Germany, meat inspection is most thoroughly carried out. In Berlin, for instance, where I studied the system, not only is each animal examined in life, but its carcase is examined after it has been killed, and, to make assurance doubly sure, certain small pieces of its flesh from different parts of the body, usually the seat of parasitic diseases of the above kind, are carefully scrutinised by the microscope by a body of male and female expert microscopists. If the carcase pass these ordeals it is allowed to be sold. It is not desirable here to discuss at length the merits or demerits of the flesh of animals as human food, but it may be said that the Jews deem it of so much importance that in the Talmud, which contains regulations for the life and habits of Jews, no fewer than 86 chapters, divided into 642 paragraphs, are devoted to this subject, and by which a carcase is either pronounced *trèf* (forbidden or unclean) or *kòsher* (lawful or clean). In this country far too little attention has been paid to this subject in its relation to the health of meat consumers; but it is to be hoped that soon, in this city at least, a system may be organised of such a kind that every meat buyer may feel secure of the wholesomeness of the meat he purchases.

The cannibalistic practice of eating raw meat, or undercooked meat, cannot be too strongly condemned. All flesh meat should be so cooked that the effect of the fire passes through every part of it. Thorough cooking efficiently destroys such a disease as trichinosis and renders "measly pork" inert.

In other ways, also, are our food supplies attacked by micro-parasites. As an example may be taken jams and

jellies; and this is more true of certain preserves than others. Strawberry jam is the favourite feeding ground of certain vegetable parasites. When a pot of this luscious preserve is opened, not unfrequently it is found covered by a vigorous growth of mould. If this be placed under a microscope it will appear of a wonderful and interesting character. You can transplant it from one vessel to another, and it will grow under suitable conditions of warmth and moisture in a variety of substances. Ripening of cheese, too, is due to the action of these vegetable and other micro-parasites, and the flavours of different kinds of cheese are due to the difference in fermentative results produced. Milk is another form of food which is an excellent medium for the growth of the microbe. Since milk is practically the sole food of a large section of our infantile population, and, in some proportion, forms part of the daily dietary of each of us, it is necessary for health preservation that the sources of supply should be beyond reproach. It is notorious that they are not so. The propagation of tuberculosis, in other forms than lung disease, amongst our infantile population, must be largely laid at the door of the milk yielded by tuberculous animals. The presence of tuberculous disease in cows which are confined year in and year out in town byres, which, in respect of cubic space and ventilation, are often deficient, cannot be wondered at. The reason is obvious when we remember that the cow was intended to live an out-of-door existence, and therefore the more confinement it has to endure the more abnormal is its environment. It is probably not far from the truth to say that about 40 per cent. of all milch cows are affected with tubercle; indeed, in a herd of 95 cows examined last August, 71 were found to be the victims of this microbic disease. This supply of tuberculosed milk, therefore, is a very live and constant danger to our infantile community. Another microbic disease which is very frequently propagated by the secretion of the cow from contamination from without is enteric fever. The experience of Glasgow alone in this respect during the last twenty-five years would be sufficient proof. It may very

properly be asked. Can we ward off these dangers, and if so, how? To this it may be answered that microbes are destroyed at the boiling-point of water, viz., 212° F.; therefore, if the milk be boiled before use, the users will be protected against possible harm from either of these diseases. But, it is said, boiled milk is disagreeable to the palate. That is true of the unaccustomed palate, but the disagreeableness passes off by habitual use. There is another way to overcome the danger, and, at the same time, partly prevent this disagreeable taste, but which needs more time and attention than simple boiling, and that is by sterilising the milk. This process consists in keeping in a bottle the milk at a temperature of 180° F. for about an hour, and then making the bottle air-tight by a clean cork or glass stopper during the cooling process. During an impending outbreak of enteric fever the safest course to pursue is to boil the milk for at least eight minutes before it is used; and for infant feeding the sterilisation of the milk as described will save no end of trouble afterwards, and will protect the infant against disease.

The food supply of animals is also afflicted at times with micro-parasites. It is only necessary to direct attention to one or two of these. In countries where rye enters largely into the food supply of the people, it is necessary to see that it is free from a parasite which, because of its poisonous action on the animal economy of both men and animals, acts very mischievously. The form of intoxication imparted to those who eat "ergotised" bread was called in the middle ages "Saint Anthony's fire." The parasite is called the *ergot of rye.* It causes animals to cast their hair, hens to lay eggs without shells, and produces in man symptoms of threatened mortification of fingers or toes, or both. Another micro-parasite which may be mentioned is that which produces a disease in wheat called *rust.* Animals who eat of such wheat or straw are seized with symptoms of illness, occasionally of an alarming character. This parasite has an interesting development. The spores or seeds attack the young blades of the wheat, and grow vigorously up to a certain point. The crop is gathered at harvest time, and

the parasite "lies low" in the straw during the winter. Before it can develop to its full maturity, these resting-spores of the wheat must feed upon another plant of a different species, viz., the barberry shrub. Here they come to maturity, ready again the next spring to renew their attacks on the wheat. This mode of development is called "alternation of generation," and is somewhat akin to what we have seen in the case of the tapeworm of the pig. From what has been said, it will be obvious that, if the barberry bushes were exterminated from the vicinity of our wheat fields, the micro-parasite would cease to be harmful. Experiment has abundantly proved this. Therefore, to avoid this disease of his wheat crop, all that the farmer has to do is to root out every barberry bush on his farm.

The well-known potato disease is also due to a micro-parasite, which not only attacks the tuber, and by causing chemical changes in its composition reduces its nutritive value, but also attacks the stem and leaves of the plant. The vine, also, is the victim of parasitic disease.

Indeed, it may be said that no animal or plant is free of disease which is micro-parasite in origin. The salmon—the lordly fish of the waters—is attacked and destroyed by the parasite called *Saprolegnia ferax.* Even the insignificant fly and the tormenting mosquito have their foes. The former, when seized in the late autumn with this parasite disease, may be seen glued to a wall, a curtain, or a window-pane by a fluffy-like growth, and from this phenomenon has originated the old Scottish proverb, "Let that flee stick to the wa'." The parasite begins to grow within the body of the animal, and from thence outwards. The mosquito is the victim of the *filaria sanguinis*, a parasite which gives rise to very anomalous and serious symptoms in man.

Proceeding still lower in the scale are certain micro-organisms which we may utilise as illustrative of their beneficial action. Everyone is acquainted with the fact that milk, after standing for a shorter or longer time, turns sour. This is due to a very minute microbe which converts

the sugar of the milk into a sour substance called *lactic acid*. This fact is utilised in the process of churning in the manufacture of butter. This process, however, is naturally arrested when the liquid contains about 7 per cent. of the acid. Then, but not till then, another microbe takes up the work, and converts certain constituents of the milk into another acid called *butyric acid*, with which is associated a very poisonous substance which has occasionally, and especially in curds, caused attacks resembling irritant poisoning. It is largely due to the above facts that butter made from cream keeps less well than butter made from whole milk.

The whole question of fermentation is associated with the presence of micro-organisms. Primitive nations quickly discovered that, if a sugary liquid was left exposed to the air, fermentation occurred, and that the sugary taste disappeared, to be replaced by a more pungent taste, which we know is due to alcohol; in other words, the microbe converts the sugar into two new chemical substances, viz., carbonic acid gas and alcohol. On these elementary facts the whole process of brewing is based, and all the alcohol that was ever manufactured, and the various kinds of it, have been produced in this manner. Within the last dozen years greater attention has been paid to these micro-organisms; and whereas before that time it was difficult to say whether a particular "brewing" would turn out good, bad, or indifferent, by making pure cultivations of these microbes, and observing in which materials they worked best, something like exactness in the brewing process has been obtained, and it is now possible for a brewer to buy his yeast of a guaranteed pure character. In the course of experiments with various forms of yeasts, it was found that certain of them would grow only freely at the surface of the liquid on which they were placed, where the air was abundant, and that others would only grow at the bottom of the liquid; and further, depending upon the position in which they grew, so was the degree of alcoholic fermentation produced. From utilising these ascertained facts, various classes of beers are made, and

they account for the difference between German and English beers—the former containing a lower percentage of alcohol and more nutritive material. Vinegar is also the product of microbic action. The admission into a wine-vat of the *Mycoderma Vini*—the name of this micro-organism—causes a complete alteration of its contents. Instead of wine, vinegar is produced. It is very discriminating in its action, for it will only begin to operate upon the alcohol when present in very dilute solutions. While the sluggard may be sent to the ant for an example, the hard drinker might take example from this organism.

Koumiss—a drink which has been largely prescribed of late years for invalids—was originally composed of the fermented milk of mares, but the process is now applied to cow's milk. It also is an alcoholic fermentation, the sugar of the milk being the source of the alcohol.

By the action of microbes in the soil, nitrogenous substances, as in manures, become available for plant-food by being converted into nitrates of soda and potash. Fortunes have been made from the huge deposits of these substances which have been discovered in certain parts of South America, and all due to the lowly microbe.

We have now seen something of the variety of action of micro-parasites of the grosser form. Let me now draw your attention to what are scientifically known as microbes, and which have been variously called germs, bacteria, bacilli, etc., in the scientific and lay press. For their examination we require to call to our aid the highest powers of the microscope—powers of magnification not less than 800 and extending up to 1500. They vary in size. A fair average size measures the 200,000th part of an inch, and it has been calculated that four hundred millions of them (400,000,000) might be comfortably accommodated side by side on one square inch of surface. The mind fails to comprehend what these figures imply, and it is only by the finest and most delicate scientific measuring appliances, called *micrometers*, that it is possible to do so. The presence of microbes in a fluid containing organic material is not difficult to demonstrate by the aid of a good micro-

scope. If a little clear beef-tea be put in an open-mouthed bottle, and the bottle be allowed to stand for a day or two, the liquid will be seen to become turbid. This is due to the action of these microbes; and if a tiny drop of the turbid fluid be placed under the microscope, they will be found present in incalculable numbers. They can be grown and cultivated in artificial nutrient materials outside the body, but they are exceedingly fastidious regarding the nature of the nutriment in which they will best thrive. One will live and thrive on one kind of nourishment which would only produce starvation in another. One demands a large supply of albuminous material for its sustenance, another will only thrive and multiply where such substances are rigidly excluded. So also with other conditions. One lives at a low temperature, another can only live where the temperature is high. Some can only live where air is in abundance, others cannot live at all in the presence of air. Their detection in the tissues and fluids of the animal body is fortunately rendered easier for the microscopist by their susceptibility to dyeing or staining by the aniline colours. In this respect also they differ. Some forms are susceptible to one colour, others to another; and it is sometimes possible to stain the microbe itself of one colour, and its contained spores or seeds of another. One kind of microbe, too, remains constantly the same, through a series of cultures, just as turnip seed will produce nothing else than turnips, or carrot seed carrots. They differ much as to their form, and from the differences in form classifications of them have been made. A simple classification is as follows, viz.:—

1. The dot-like form, or *coccus*, from the Greek word signifying a berry or cell. These may either take the form of a single dot, a double dot, a quadruple dot, or a string of dots like beads on a string.

2. The rod-like form, or *bacillus*, from the Greek word signifying a stick or rod. While all of this class present generally this minute rod-like form, some exhibit sufficient departure from this to entitle them to have special names; thus the *bacillus* of glanders—a disease of horses—is called the *bacillus malleus* from its rude likeness to a hammer,

and that of cholera, from its likeness to the mark of punctuation, *bacillus komma* or comma.

3. The spiral, or corkscrew form—*spirillum.*

Belonging to the first class are the microbes of fowl cholera, swine fever, measles, scarlet fever, smallpox, cow-pox, foot-and-mouth disease, pneumonia, erysipelas, and others; to the second class, anthrax or splenic fever of cattle and wool-sorters' disease in man, tubercle, glanders, enteric fever, cholera, diphtheria, lockjaw or tetanus, leprosy, and others; and to the third class, that of relapsing fever, which has not visited Glasgow for the last twenty-five years (1870).

All of these microbes propagate their species by means of spores or seeds. These spores are considerably less in size than the parent microbe, but like the seeds of plants they are capable, when dried, of offering greater resistance to adverse conditions than the parent. For instance, while practically all microbes are destroyed at a temperature of the boiling-point of water, the spores will survive the process of boiling unless it be continued for several minutes.

In view of the foregoing facts, therefore, the microbic theory no longer exists simply as a working hypothesis, but as a living substantial fact which requires to be reckoned with at many points.

We are now in a position to understand how microbic diseases are spread. Everyone knows that an infectious disease is capable of spreading from place to place, from house to house, and from person to person, and most people know that the something by which it is spread is called *infection.* This infective material has, in the course of centuries, been known by a variety of names, such as *effluvium* (that is, something which flowed forth from the infective person), *miasma* (something which defiles), *influence* (from which the Italians give the name *influenza* to the disease which afflicts the civilised world), *virus* (poison), and *contagium* (that is, something which was got by coming in contact with the infective person), and others. But modern research has indisputably proved that this

infective material is nothing more nor less than the microbes or spores or both of the disease which are thrown from the body of the infected person by one or more channels. And this is true of each infectious disease. By reason of the infinitesimally small size and light character of these microbes, it is not difficult to comprehend how they may be wafted about by currents of air or become attached to the clothing of the person. Hence infective matter essentially consists of minute particles which obey the law of gravity. They are therefore found most plentifully near the surface of the ground. The length of time during which infective material is capable of doing mischief after it has left the body of the infectious person is largely determined by its environment. Abundance of fresh air and sunlight quickly destroy it; absence of these tend to prolong its virulency. Hence it may well be termed "the plague that walketh in darkness."

Enough has already been said regarding the omnipresence of these micro-organisms. From their effects upon man they have been divided into those that are harmless and those that harmful or pathogenic, *i.e.*, disease-producing. The media by which they are conveyed to man, and by which they are apt to find entrance into his body, apart from direct wounding of the surfaces of the body, are air, water, and food.

Air.—The number of micro-organisms present at any given time in any given atmosphere depends upon (1) the presence or absence of animal life, man included; and (2) certain conditions of weather. They are more plentiful in the air of an inhabited place than in the air of the country, and when we get ten miles out at sea the number falls nearly to zero. The more populous the place the more plentiful the microbes, hence the necessity for the provision of means whereby abundant circulation of air may be produced. Well-ventilated houses, wide streets, open spaces —elbow-room generally—act as wholesome deterrents of their harmful results. In dry, dull weather they are more plentiful in the air of the town than in bright, sunny, or wet weather. While an abundant rain-fall may be objec-

tionable in some respects, its beneficial action in washing and purifying the air and in cleansing sewers has not been sufficiently appreciated. Overcrowding of apartments, with other concomitant conditions, such as poorly-nourished individuals and dirt, is sure, sooner or later, to set up typhus fever. Typhus fever cannot exist alongside of cleanliness and free ventilation. And what is true of typhus fever is true, although in lessening degrees, of other infectious diseases. By attention to such points the outbreak of many diseases may be limited, and some entirely prevented.

Water is the most common vehicle, after milk, of enteric fever, and the most common of cholera. Attention to purity of water supply, therefore, is a matter of the primest importance. Glasgow possesses one of the purest and most plentiful supplies of water in the world, but even this supply must be closely safeguarded against possible contamination. Sufficient credit has not been given to the Corporation of Glasgow for its prudent foresight in conserving the purity of Loch Katrine for future time by buying up the feuing rights of its foreshores. This was money most excellently spent, and like bread cast upon the waters, shall be found after many days. Even the purest water, however, contains microbes, but of an innocuous character. Every drop of Loch Katrine, for example, contains about twenty microbes, and if it be allowed to stand for six days in a close vessel at 65° F., the twenty will have become multiplied into ten thousand. But the whole ten thousand may be swallowed without any harm ensuing to the drinker. It would be an entirely different affair, however, if, perchance, the microbe of cholera or enteric fever found an entrance.

Even freezing does not free a water of microbes unless the process of alternate freezing and thawing be adopted several times. It is true, to a certain extent, that the process of freezing will purify a water in respect of freeing it from grosser suspended matter, but it ceases there. From this it is obvious that frozen water is not protective against disease, and that ice-cream may convey disease if the

materials of which it is composed contain specific microbes, say, of enteric fever.

Dust is the favourite harbinger of microbes. The prevalent mode of dry dusting is simply a farce, and consists only in dislocating the dust from the place on which it lies into the atmosphere of the room, to settle again in a new place after the atmospheric disturbance has subsided. It is time that it should give place to moist dusting by a damp cloth, since by this means the dust is lifted. It may mean more trouble, but it is worth it. The old-fashioned mode of sweeping a carpet previously sprinkled over with moist spent tea leaves is infinitely preferable to the more modern sweeping-made-easy machines of American origin. It may be said without contradiction that in an infected room there is much more to fear from the dust which has settled in the crevices of the walls, on the wall paper, and on the floor than from the air of the room. Upon this fact is based the German mode of disinfection, by rubbing the walls with bread, and afterwards burning the bread.

Food.—Various kinds of food afford excellent breeding-grounds for organisms, particularly those kinds which are rich in albuminous substances. Pies of veal, or beef, or pork, brawn, sausages, tinned meats generally, all of which are usually eaten cold, have each upon occasion given rise to serious disturbances in those who have partaken of them, with sometimes fatal results. The same is true of cheese, and shellfish, such as oysters and mussels. The symptoms which are induced are those of irritant poisoning, and are apt to be confounded with irritant poisons of the mineral class, such as arsenic. The cause of the mischief is the products which result from the action of certain microbes in a limited air-supply upon the albuminous substances of the food, and which, from their poisonous effect, have been called *toxins*, and, from their production in albuminous substances, *albumoses*, or the more common name of *ptomaines*. There are certain practical hints regarding the proper making and keeping of pies and canned meats which, if observed, may prevent the above possibility. Every cook when making the crust of a dish-pie ought

always to leave one or more vent-holes in it. This enables the free admission of air on cooling, and prevents the growth of those microbes which produce putrefactive action. A closed pie-crust, on the other hand, enables those organisms which can only live and thrive in the absence of free air to grow vigorously. In almost every case where a series of persons have been seized with illness after eating of a cold game, beef, pork, or veal pie, the above conditions have existed.

The consumption of meat preserved in tins being largely on the increase, it is necessary that a word of guidance should be said whereby a sound "*can*" may be recognised from an unsound one. The principle of preserving food in tins is briefly this—The meat is cooked in cauldrons or vats, and from the cauldron it is placed in the tins. The lid of the tin is all soldered down except a tiny pinhole. The filled tin is placed in a boiling-bath, and the contents of the tin are made to boil. This is known by the emission of a tiny jet of steam from the pinhole in the lid. When this has been allowed to go on for a few minutes, the workman drops from a solder-iron, on to the pinhole, a drop of solder. By the boiling process a portion of the air of the can has been forcibly expelled, and by the soldering process air is prevented from re-entering the can when its contents cool. The meat is thus hermetically sealed from the air, and in this condition will keep for an indefinitely long time. By the exclusion of the air no microbes can enter, hence the meat remains fresh. On account of the foregoing process the pressure *within* the can is less than that *outside* it, hence the top and bottom of the can are forced inwards toward the interior of the tin—are, in other words, *concave* in shape—and if pressure by the thumb or hand be made at these points no impression will be made. Should, however, in the packing or transport of the goods, any breach, however minute, be made in the can, air is permitted to enter, and with the air putrefactive microbes. When this happens the pressure *within* and *without* the tin becomes equalised, and this fact becomes apparent in the physical appearance of the can. The top and bottom do not now bulge inwards, and if pressure be

made by the hand a crackling noise will be perceived, which demonstrates the presence of the admitted air. This is the danger-signal, and *this test should be applied to every meat tin before the purchase is effected.* By such simple means a dangerous and painful illness, and maybe death itself, may be averted. Vegetable broth, which is a favourite dish with many persons, is also a splendid feeding-ground for microbes. There is no danger whatever if the quantity made is consumed shortly after it has been cooked. The danger arises where the surplus made is to be kept for a second day's supply. During this short interval of time millions of microbes develop in it, and the person who partakes of the broth cold, or imperfectly heated, may be thankful if he escapes with only a temporary discomfort, for sometimes violent irritant symptoms ensue. It ought to be widely known that, before second day's broth is served up for dinner, *it should be boiled briskly for fifteen minutes,* water being added if necessary. These apparently very trifling matters are exceedingly important, and if attended to will contribute to comfort and health.

We now pass on to consider some of the diseases which are directly due to the action of *pathogenic* (disease-producing) microbes, which diseases are usually called *infectious* diseases. It may be said, once for all, that every infectious disease, from smallpox to mumps, from cholera to chicken-pox, is the direct outcome of the admission into the animal body of the specific microbe of the disease. It is quite true that respecting some of these the specific microbe has not yet been discovered and isolated, but sooner or later they will be. There are certain infectious diseases which are common to both man and animals; that is to say, that the fluids of the body of an infected animal, when admitted into the body of man, induce the same disease, although the symptoms in the latter may not be precisely on all-fours with those in the former. Tuberculosis is an example of this. It attacks cattle, fowls, and other animals, and man, and it is transmissible from the one to the other by the eating of imperfectly-cooked tuberculous meat or by the drinking of raw tuberculosed milk. It is also infectious, in a *limited*

way, from person to person. The microbe may be found abundantly in the sputum of the victim of consumption, which is tuberculosis of the lung. Within recent years much unnecessary alarm has been raised regarding the infectivity of this disease, and upon exaggerated notions of this it has been urged that similar precautions should be adopted regarding this disease as are presently in operation against smallpox or scarlet fever. The popular opinion still prevalent, but which must disappear before advancing knowledge, is that tuberculosis or consumption is hereditary. This view must be summarily dismissed. It is quite true, at the same time, that the predisposition or tendency to the disease is handed down from parent to child, and that the child of phthisical parents is more vulnerable to the influence of the tubercle-bacillus; but the hereditary influence stops short at the predisposition. To hark back a little. It must be acknowledged that tuberculosis is infective, but the chances of infection are minimised whenever we provide abundance of fresh air. Wherever it has been proved to have been transmitted from a sick to a healthy person, two common conditions were usually to be found, viz., intimate relationship between the persons, and unhygienic environment, chiefly imperfect ventilation of the sick chamber. I have no sympathy with the movement which would shut up within the wards of an isolation hospital everyone who was the pitiful victim of tuberculous lung disease. At the same time, every reasonable precaution ought to be taken by private individuals, and by the local authority, to prevent its spread. The precautions which ought to be taken by the friends of the patients are these, viz.—

1. The patient should sleep alone, in a room occupied solely by himself at night.

2. The expectoration should be received upon pieces of cotton or old linen, which should then be burned, or into a hand-spittoon previously partly filled with carbolised water, then mixed with sawdust, and burned at intervals of a few hours. So long as the expectoration is kept in a moist condition, by no chance can the microbes be liberated into the atmosphere of the room.

3. The furniture of the room should be dusted with a *damp* cloth, and the carpet swept after sprinkling with damp tea leaves.

4. Should the patient die, the local sanitary authority ought to be asked to carry out the measures of disinfection usually adopted after any of the notifiable infectious diseases.

The local authority has also its duty in this matter, which may be summed up in the following points, viz. :—

1. To wage increasing warfare against the sale of the milk of tuberculosed cows for human food.

2. To insist rigorously on the provisions of the Dairies, Cowsheds, and Milkshops Order being carried out in town byres.

3. To employ skilled veterinary assistance in the detection of milch cows suspected to be suffering from tuberculous disease.

4. To employ disinfection of the clothing and bed and room of the patient where death has been registered as due to tubercular phthisis.

5. To disseminate popular information regarding the infectious character of the disease by means of pamphlets or otherwise.

Anthrax, or splenic fever of cattle and other animals, known by the names of wool-sorters' disease and malignant pustule in man, is another of the diseases common to both. It is a virulent plague of cattle, and, up till a few years ago, caused serious financial loss on the Continent. Thanks, however, to the researches of Pasteur, Koch, and others, a protective vaccine was devised by which, after injection into healthy animals, they were protected against a subsequent attack of the disease. The enormous practical value of this discovery, even if considered alone, would be a triumph of man over the mysterious secrets of nature; and already millions of money have been saved, and untold suffering in animals has been prevented by this discovery.

The disease is communicable to man only by inhalation or absorption of the infective material from some part of the carcase of the infected animal. By reason of the mysterious character of a disease which periodically broke out among the wool-sorters of Bradford and other places, and which,

after careful investigation, was indisputably proved to be identical with anthrax, it received the name of wool-sorters' disease. In like manner, butchers, tanners, and horn workers, who handle the skins or horns of infected animals, are liable to absorption of the infective material into small wounded surfaces of the body. The disease then takes the form of a very angry boil, which produces severe constitutional disturbance; thence its name, malignant pustule. Hair-workers, too, are also liable to this disease. A few years ago two women employed in sorting hair died from this disease in Glasgow.

Glanders—a disease of horses—is also communicable to man. In the same category is foot-and-mouth disease, a case of which in the human subject was lately seen in this city. Influenza in man is very often associated with "pink-eye" in horses; and this connection has been so frequently noted by observers in different places that there is good reason for believing that the intimate cause of the disease is identical. Scarlet fever in the human subject is akin to a certain ulcerated condition of the udder of the cow; so, likewise, is diphtheria. But the association between them has not yet been closely enough traced home to enable any precise statement to be made.

From what has been said, therefore, the preserving of animals from certain infective diseases is tantamount in practice to the reduction of the risks to human health, and ought to be therefore, as, to a certain extent, it presently is, the sacred duty of the State.

We now approach the class of microbic diseases which are peculiar to man, as smallpox, cholera, typhus fever, enteric or typhoid fever, scarlet fever, whooping-cough, diphtheria, and others. Time will not permit me to dwell at length upon each of them. Since, however, I am addressing a body of auditors who are connected in some way with the plumbing craft, it will be my duty to direct your attention especially to those diseases which are associated with defective arrangement in the fittings for the disposal of the waste water and night-soil of a house, and for the water supply. In every populous place where a public sewerage system, like a public gas or

water system, exists, the plumber plays a very important part. He is master in his own domain. But it entirely depends upon whether he knows how to do his work properly, and what the object of his work is, whether he fulfils aright his part in the public economy. He holds the key of some of the gates by which disease or death may enter the house, and his is the duty of not only laying and fitting the necessary arrangements for carrying off objectionable matters from the house, but *of preventing them or their products from returning back into the house.* He shares the duty with the sanitary authority of preserving the public health against evils such as have been indicated.

There are certain diseases which are directly associated with defective house fittings, house drains, and drain and sewer connections. We depend upon the plumber and sanitary engineer to protect our health and our lives, by assuming that they will adjust these fittings in such a way that pathogenic microbes or the products of putrefaction may not contaminate the atmosphere of our living rooms or our water supply. Failure to do this is culpable, and ought to be penal. If it could be guaranteed that every craftsman was conversant with the craft he professed, and did his work in a craftsmanlike fashion, the guarantee would be ready to our hands; and this, I take it, is the aim and object of the Association under whose auspices we are met to-night.

The diseases which have a direct relationship with defective sanitary fittings are two in number, viz., enteric fever and diarrhœal diseases, and diphtheria. To a large extent they may be prevented by efficiency of fittings for soil disposal and water supply. Associated with the latter is cholera. This disease is almost always connected with contaminated water, and where a public water system obtains, the risk of contamination is always greatest either at the point of collection (the lake or reservoir) or at the point of distribution (the house). Where the supply is a constant one (that is, with the pipes standing full and the water always on tap), the risk of contamination is minimised. But where the supply is intermittent (that is, where the pipes are alternately full and empty), necessitating

storage cisterns in the house for the supply of those periods during which the water is "off" from the main supply, risk of contamination is enormously increased. This latter condition does not yet cease to exist in this city, although the cases are few and far between and in old properties. Let me give you from my own experience a few facts regarding the effects of contaminated water from a storage cistern which occurred in the city within the last few years. In a family, occupying a house of four rooms and kitchen, periodic illnesses of a character which raised the suspicion of drain connection, viz., enteric fever, sore throat, general depreciated health, broke out. The doctor was hardly ever out of the house. The drains were examined, and found in good order. Still these illnesses periodically recurred. The closet and bath-room was a "pokey" place. Previous enquiry regarding the water supply was met by the reply that the supply was obtained from the main. A personal examination, however, quickly revealed the fact that this was not correct, although the former information had been received from the landlord, in good faith it is believed. The water supply of the house was obtained from a cistern which stood in the bath-room, and which was covered partly by a lid. We made an analysis of the water, and found that it was seriously contaminated with animal organic matter. An examination of the cistern was thereupon made, when the following foreign bodies were found, viz., the bodies of two rats in an advanced state of decomposition, and the skeletons of both rats and mice, together with a large quantity of lime and dirty sludge, the accumulations of years. A copy of the analysis was sent to the sanitary office, along with a brief account of the health-history of the family. It is due to the sanitary authority to say that, immediately after receipt of this information, measures were taken to establish a water supply from the main. Ever since the health-history of that family has been normal.

Probably too much has been made of late years of the existence of ignorance on the part of the plumber. Those who are acquainted with the problems of his work know that he is often handicapped by a niggardly landlord or

factor as to the kind of "job" and character of fittings he is permitted to put up. At the same time, it must be clearly stated that all plumbers, like any other body of craftsmen, or any body of professional men, are not equally competent. Further, the work of the plumber is different from that of almost every other class of workmen employed in the erection of a building and its fittings, in respect that it has to do with those channels whereby often diseased products pass from a house, and any defect of structure or imperfection of design of these fittings is apt to betray itself by serious consequences. And in order that a plumber may carry out his designs and do his work intelligently, he must needs make himself acquainted with problems which do not usually lie within the domain of the craftsman, but in that of the physicist and physician. The work that has been initiated by the Worshipful Company of Plumbers, and which is being steadily carried on in several centres in Scotland, is even now bringing forth good fruit; and as the general public becomes more educated as to its aims and effects, which may be interpreted to mean intelligence and efficiency of every craftsman whose name is registered, and by which fact a guarantee of fitness is secured, the whole plumbing craft will become elevated to a position it never before held; the public health, so far as they can protect it, will be conserved, and incompetent workmanship will be penalised. In conclusion, it may be said that this movement has the hearty support of every sanitarian in the country, and it has my hearty allegiance.

The lecture was illustrated on the screen by the exhibition of 120 micro-photographic slides of the different micro-parasites and microbes mentioned, in addition to many others. At the conclusion a cordial vote of thanks was accorded to Professor Glaister on the motion of ex-Deacon-Convener Copland, C.E., seconded by Mr. James Anderson, master plumber, of Messrs. James Ingleton & Co. The proceedings terminated with a vote of thanks to the chairman, proposed by Councillor John King.